AMRAD NEWSLETTER

Amateur Radio Research and Development Corporation December 1982

Annual Meeting Notice

The AMRAD Annual Meeting will be on December 6 at 7:30 P.M. at the Patrick Henry Branch Library, Vienna, Virginia.

Our guest will be Vic Clark, W4KFC, President of the American Radio Relay League.

Ballots will be passed out to members for the election of two directors and two alternates. Names placed in nomination at the November meeting were:

Jeff Brennan, WB4WLW (incumbent director)

Bill Pala, WB4NFB (incumbent director)

Richard Barth, W3HWN (incumbent alternate)

David Borden, K8MMO (incumbent alternate)

Members who will not be able to attend the meeting may vote by mail. Your ballot should be a 3 x 5 inch card on which you have written the names in the order of your preference (first preference at the top of the card). Enclose the card in an envelope showing your name and return address and mail to AMRAD Election, 1524 Springvale Ave, McLean, VA 22101 to arrive by December 6, 1982.

Also at the meeting, we hope to have a video tape that's better seen than described.

Last Call for Life Memberships

This will be your last opportunity to send in your AMRAD life membership application if you act now. If you're actively considering it, sitting on the fence, vacillating, or are just barely thinking about it, fill in the application inside the last page and send it with your check to Bill Pala to arrive before December 31, 1982.

AMTOR Teleconference on December 2

Bill Meyn, K4PA will be the seminar leader on the next IEEE/LIMARC session on December 2 at 8:30 P.M. EST via AMRAD's WD4IWG/R on 147.81/.21 MHz in the Washington, DC area and at least 15 other repeaters throughout the country. Bill's topic will be AMTOR, an RTTY system which is on the air in the U.S. under a Special Temporary Authority (STA) from the FCC. There will be Q&A periods about every ten minutes. Vic Clark is signed up for the March 3, 1983 teleconference.

30-Meter Operation is Now Legal

U.S. amateur operation on the 10-MHz band has been authorized by the FCC since October 28, 1982. Requirements are: General Class or higher license, 250 watts maximum input, A1 and F1 emissions only, 10.100-10.109 and 10.115-10.150 MHz.

FCC Releases New Beacon Rules

Effective January 3, 1983, new rules go into effect regarding beacons.

Previously, the FCC rules required that beacon operation take place only under direct, manual control. The Commission has routinely granted Special Temporary Authorities (STAs) for automatic control of Amateur Radio beacons, since experience has shown that automatic control is adequate for compliance with the rules.

In comments made to the Commission, the ARRL pointed out that the FCC's choice of 28.08-28.10 MHz for beacon operation would increase the possibility of interference to cw transmissions in this portion of the band. Therefore, the League suggested that the frequencies be changed to 28.2-28.3 MHz. These frequencies would then be consistent with the International Amateur Radio Union (IARU) International Beacon Project Plan, and help solve the QRM problem at the same time.

The FCC-approved frequencies for automatic beacon operation are:

28.20- 28.30 MHz
50.06- 50.08
144.05-144.06
220.05-220.06 and 222.05-222.06
432.07-432.08

Beacons that are manually controlled are not frequency restricted. Emission types AØ, A1, FØ, F1 or A2J are authorized for beacon use. When F1 or A2J emissions are used, the radio or audio shift must be less than 900 Hz.

Maximum legal power for beacon operation must not exceed 100 watts input. Beacons must identify once each minute with the station call sign followed by a slant bar and the letters "BCN" or "B" when using cw. The word "beacon" is to be used when identifying by voice.

No beacon can operate on more than one frequency in the same band from the same location.

Automatic beacons must also follow the National Radio Quiet Zone rules for repeaters (see QST, June 1981, p.53). Written notice of proposed or modified operation of a beacon in the Quiet Zone must be given to the Director of the National Radio Astronomy Observatory, P.O. Box 2, Green Bank, WV 24944. This requirement does not apply to manually controlled beacons.

The Commission emphasized that while it was not placing frequency restrictions on manually controlled beacons, it would not tolerate any interference to other stations. FCC Engineers-in-Charge are authorized to terminate beacon operation in case of any infringement of the rules. Operation may not resume without prior approval of the Engineer-in-Charge. Thanks The ARRL Letter and the American Radio Relay League.

A New Direction for the W9JD FEC ARQ System

Jerome T. Dijak, W9JD/2
215 Tareyton Drive
Ithaca, NY 14850

Last month I discussed the recent history of developments with the W9JD FEC ARQ System. This article discusses the state of the system as well as work underway.

Keyboard

Last time I alluded to three aspects of the current system design that Wally, WØPHD and I were not satisfied with. The first of these is keyboard response while receiving. The keyboard is polled once during each bit time of each character transmitted or received by the system. While the radios are transmitting, keyboard response is fine, since the system keeps up a constant stream of outgoing data, and so the keyboard is polled regularly and often.

The keyboard response is also fine in the receive mode when the incoming signal is good enough that the system recognizes a continuous stream of data. The problem occurs when the incoming data drops out for a while — keyboard polling stops when the system is not actively decoding incoming characters. Even with reasonable amounts of QRM and QSB, we have found the irregularity of keyboard response while the radios are receiving to be annoying.

Data Rate

With all that the current software must do during each bit time (polling the keyboard, updating the video display, and processing buffers), I have experimentally found the upper limit to system data rate with the current design. It is about 400 b/s. While that is okay for hf work, I would like the system also to work at higher rates for use at vhf and uhf. For a nice round figure, I would like the ability to run up to 9600 b/s.

Universality

We've put a lot of time and effort into developing this system, but it's not of much use if only 2 stations in the world ever use it. The present system design, with its extensive reliance on software timing loops and interleaved software modules with critical execution times, does not lend itself to straigntforward implementation on other types of computers using different video display and keyboard interface strategies. (This task is in the realm of "possible, but probably requiring more work than most would be willing to spend.")

A New Tack

So how are we going to address these problems? Keyboard response is being rectified by going to an interrupt-driven scheme, where keyboard data will be accepted whenever a key is pressed, and this will be determined with an interrupt. This will give us very nice keyboard characteristics, at the expense and complexity of now requiring someone implementing this system to be able to properly wire-in to his CPU's interrupt-handling capabilities. While this will complicate the matter of spreading implementation of this system around, dealing with interrupts is also necessary for the next step, below, so we are stuck with it. (It can be a new learning experience.)

8251. To enable the system to run at higher data rates, the tasks of parallel-to-serial data conversion (and vice versa) must be handled in some way by hardware. I have chosen the 8251 USART chip to do this. This chip sends and receives serial data to the outside world while interfacing to a microprocessor's data bus in 8-bit parallel fashion. Bytes are sent to, and read from, the 8251 in response to CPU interrupt signals it generates.

Software Impact. As a result of the above two system design changes, the software must also undergo some major redesign. Some complexity will be added to the software to handle interrupt processing, but a large amount of complexity will be excised since modules need no longer be so highly interleaved and critically timed. With many of the time-critical functions being handled via interrupts, the remainder of the software can be streamlined quite a bit.

Status

The hardware to allow interrupt processing, the 8251 and its required data clock synthesizer, the data bus/address bus interfacing, and address decoding logic require considerable space. As a matter of fact, they take up one 4.5-by-12-inch board fairly well. I have dubbed this interface board the "ARQ Board" (clever, huh?), and it provides the interface between the bus structure of my Digital Group computer and a terminal unit used with the radios.

I am building two of these boards (one for me and one for WØPHD as well as two high-quality hf terminal units so that we can try some 300 b/s work on the 20-meter band. These rather large projects are sharing my spare time with everything else, but they are moving along. As this is written, the first ARQ Board is complete, and the first terminal unity board is 95% complete. As soon as testing of both is successfully accomplished I am going to "clone" both of these for WØPHD. Then while he is getting them absorbed into his station, I am going to redesign the software to run with the new hardware. (This should keep me off the streets up through the Christmas holidays, at least!)

Summary

By taking the plunge and building up a special interface board to handle parallel-to-serial data conversions and handle interrupts, I am hoping that we can greatly simplify the software and make it easier to implement on other computer systems. In the process, we will also gain operation at much higher data rates as well as nice keyboard operation regardless of the quality of the incoming signal. At the same time, those people desiring to run the FEC ARQ system, and not afraid to build up a moderately complex hardware board to do it (mine is point-to-point wired), and not afraid to run their system in an interrupt-driven mode, and not afraid to do some minor software work to adapt the system software to their particular machines, will be able to implement the system.

I am gambling that this will result in something a little easier to implement with other computers and that this will result in more widespread use of the FEC ARQ System.

PROTOCOL

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Host Computer News

My AMRAD packet radio host computer works, still. Actually, it always worked, but now thanks to the suggestions of Tom Clark, W3IWI and Terry Fox, WB4JFI, it works even better. I have received several letters encouraging me to write more about applications and the host computer in particular, that is why you keep seeing it here. In this months episode of David and the computer, I had managed to do two bad things in the host software. First, I had the Cal Teague option turned on tnat adds a line feed after carriage return, since line feeds terminate a packet. That was bad for hosting. First, the extra character (line feed) was echoed. That meant that CP/M (the real secret of hosting is changing your CP/M BIOS to do the job) saw some character after an intrinsic command (like DIR for directory listing) and terminated execution of the intrinsic command right now. Thus application programs would work, but CP/M intrinsic (built-in) commands did not work. TYPE is a CP/M intrinsic command that is important. Typing files is a common thing in CP/M, meaning to list a file to tne console. After I got tnat option turned off, the packet terminates after 64 characters or one of the special CP/M terminators mentioned previously in this column (like > or ? or :). Another bad thing this had caused was the addition of an extra blank line between legitimate lines. Users thought that their terminals had gone bad. Once I had that fixed I thought my troubles were over. Then Terry pointed out that tne callsign being sent in International cw code was "Q8MMO". That happened because the CWID system designed by KA6M depends on space-to-mark transistions for cw. Thus, the first thing sent must be a space for a while before beginning the K8MMO. That was quickly fixed by reburning the PROMs. Then all future changes can be made by changing the CP/M BIOS (Basic Input Output System). Terry suggested that it would be good to see what the packet user was typing on my computer. If the user was about to do something bad (ERA *.* for example), I could terminate the operation and chastise the user. The BIOS was modified to allow dual consoles. The packet Terminal Node Controller was one console, and a standard terminal in the shack the other. Now I was in control and could nelp the user along. At last we are ready for some real hosting.

WATCHER

I have begun work on my first packet application. To answer a reader's question, the software I write I will eventually give away if anyone wants it, and it is written in PASCAL MT+. I just got a copy of JRT PASCAL which might be good because the distributors encourage giving it away (no selling please!). The price is also low. This may force me to switch to it if I do not lose too much capability (MT+ is supurb professional software). I have to check how you link assembly language and PASCAL programs together which is essential in this packet work. In WATCHER, I set in a loop counting down a counter, waiting to send a beacon every 8 minutes or so.

The beacon says, in packet:

> AMRAD Packet Radio Host Computer On-Line Connect to K8MMO* and type HELP For Instructions

I am sitting in the loop waiting for the 8 minutes to be up or someone to connect up and speak to computer. When something is received, due to connect up (no monitor mode in Hosting remember!), I kick the user out into CP/M where he types HELP (unless they do not need any help) which runs the HELP program which reads out the HELP file. I can put the latest system news into the HELP file.

This program is nothing new and AMRAD's Chief Engineer, Bob Bruniga, was doing this sort of thing years ago, but not in packet. My problem with WATCHER is how to get back into it after the user is done using the computer. I cannot require the user to type WATCHER and thus activate the program, so how do I get it going again? I need a program that runs on a timer.

Maybe I should put the WATCHER in the operating system and if nothing is typed for eight minutes, output the beacon to the packet port (what if the user is connected and just goes away for eight minutes?). I will be solving these problems by some trickery and will report on my progress in this column.

New Packet Chip

Terry Fox, WB4JFI, is working with a new packet chip, the 8530 SCC Serial Communciations Controller from Zilog. It is a two-channel device, just what we need for networking. I will report on his progress and details on the chip next month, unless he wants to write about it. It is an exciting chip which is priced the same as the 8273 and does more than twice as much with less supporting logic.

School of Modemology

If you need a crash course on modems, Rixon Inc. is offering two-week data modem Application, Installation and Maintenance (AIM) courses in 1983 at the following starting dates: Jan 3 & 24, Feb 28, Mar 21, Apr 11, May 2, Jun 6, Jul 11, Aug 1 & 22, Sep 26, Nov 7 and Dec 5. The course fee is $595.00 per student. Eligibility: you must own, lease or distribute RIXON (R) equipment. Registration is by phone to 301-622-2121, ask for Customer Engineering and provide Purchase Order number. The curriculum includes: EIA interface, FCC Part 68, Bell 103, 201C, 202S, 208, T209A multiplexer, and 212A.

X.25 Short Course at GWU

George Washington University, Continuing Engineering Education, will present "Public and Private Packet Switched Networks - The X.25 Protocol," Course No. 863DC (Washington, DC), February 10-11, 1983. The course instructor will be Roy Rosner. The course includes: introduction to packet networks, details of packet-switching techniques, network interface protocols and standards (X.25, X.75, X.28, X.29, X.3, X.21, ADCCP), common carrier services and private networks. The course fee is $625.00. Phone 202-676-6106, 800-424-9773, telex 64374 (international).

Deaf Telecommunications Van Dedication

The deaf telecommunications van described in an article by Rudy Auslander in the July-August 1982 AMRAD Newsletter will be dedicated on Saturday, December 4, 1982 at 2:00 P.M. at the Mill Neck Manor Lutheran School for the Deaf, Frost Mill Road, Mill Neck, NY 11765.

Radio Shack Outside Software Program

Radio Shack is launching a new program which offers a variety of support and assistance services to third-party software vendors who are developing software to run on any of Radio Shack's computers. According to Radio Shack... "Unlike our earlier policy, the software being developed with the support of our new program does not have to be intended for eventual sale tnrough Radio Shack stores and dealers." If you want information on the program, write Phil Kitchen at 1300 One Tandy Center, Ft Worth, TX 76102.

Call for Papers (January 7, 1983 Deadline)

The Wasnington, DC Chapter of the Association for Computing Machinery (ACM) is looking for papers for their 22nd Annual Tecnnical Symposium to be held at the National Bureau of Standards, Gaithersburg, MD on June 23, 1983. The topic is: "Microcomputer Systems: Tools or Toys?" Papers can be on design development issues, applications, software, hardware, human factors, communications/ networking, programming languages, data-base management, and personal computing.

Papers should be 10 to 20 double-spaced pages in length. 400-word summaries on current research will be considered. All papers should be sent to Mr. Stweart A. Grossman, 2 Fallswood Ct, Potomac, MD 20854. For information contact: Ms. Lorraine Lynch Nagy, 301-972-4739 (home), 202-676-0037 (work).

tion in case of any infringement of the rules. Operation may not resume without prior approval of the Engineer-in-Charge. Thanks The ARRL Letter and the American Radio Relay League.

Employment Opportunities

There's a job open for an applications engineer (BSEE or equal experience) familiar with micro-computer software and nardware. Call Sid Schwartz, 301-459-7900, weekdays.

A small Bethesda, MD computer company is looking for an entry-level technician who can learn to assemble S-100 systems and troubleshoot in the field to the board level. Call Paul Rinaldo, W4RI, 703-734-0878 for contact info.

Book and Software Reviewers Needed

From time to time AMRAD receives books and software for review. We now have two items which are looking for volunteers to review (and keep them if desired).

The first one is a book by Donald H. Beil entitled "The VISICALC (R) Book - Atari (R) Edition," published in 1982 by the Reston Publishing Co., Inc.

The second is software called "Bug Byter" a scrren-oriented 6502 debugger by Computer Advanced Ideas, for the Apple II (tm).

If you are interested in reviewing either of the above for the newsletter, please contact Paul Rinaldo, 703-734-0878.

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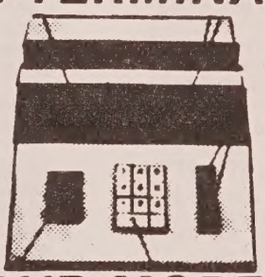

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Tucson Amateur Packet Radio Activities

Den Connors, KD2S
P.O. Box 22888
Tucson, AZ 85734

The TAPR terminal node controller beta test is finally upon us! We have ordered the parts for the pc boards, and Lyle, WA7GXD has populated one of the check boards, tested all of the required hardware and is ready to give the go-ahead for the 180 boards needed for beta test. Here's how it happened...

Pete Eaton, WB9FLW and Bill Reed, WD0ETZ had been tapping the resources of St. Louis looking for a good pc layout facility and a group that could make our custom transformer. They were very successful with both tasks. The pc layout was sent to us in the first week of November, and after a careful look-see by Lyle, was modified and approved. The "final" layout arrived that weekend, and has again been checked. As the layout was shipped, Pete and Tom Brickey, WB0WRK hid in a pc-fabrication shop for a period of time, and out popped three extremely good looking "check boards", which are now in our hands here in Tucson. Also sitting down here is a copy of our transformer, with windings for + 12 volts as well as a goodly quantity of +5 volts, after regulation. Lyle has put a board together, and he and Mark Baker will assemble a second unit later.

The final controller ended up being everything we've been promising, and quite a bit more. Lyle has included 24k of 2764 EPROM and 6k RAM on all boards going to test sites. The on-board Bell 202 type modem has had added to it a four-pole switched-capacitor audio input filter, and still has the built-in modem calibration circuitry. The off-board power supply circuitry is now entirely on-board, less the transformer and fuse holder. We did go 6809 of course, and kept simultaneous serial and parallel port capability (important for some linking experiments we're working on). The on-board wire-wrap area now has power and ground rails, with all three voltages available. It's quite a hummer. We'll be shipping out the boards with solder masking, special coating over the traces and silk screening for component identification. All cables and connectors will be included, less the non-standard radio connector. We hope to have completed shipping all units to Beta sites before the Christmas holidays, and we're currently on schedule, for a change.

(Please note that we don't sell these things for a living, but for those hams interested, we'll be coordinating efforts for further distribution with all of our beta site coordinators.)

And protocol... That brings up the software activities, which are now as geographically distributed as the hardware effort. As noted elsewhere, the AMSAT packet meeting held in October brought forth a standard protocol for the AMICON effort. The level 2 (data-link-layer) protocol chosen is not compatible with the current TAPR dynamic-addressing software being developed by Marc Chamberlin WA7PXW and Dave McClain N7AIG. The TAPR/DA routines are much more efficient at sending short packets, shaving 19 bytes off of the packet header in a repeated message, leaving more milliseconds for other transmissions. No guarantees as to delivery date will be made for this protocol, but Marc is now using some very sophisticated hardware/software tools that he and Dave have been developing, and information will be forthcoming as available.

TAPR is nonetheless committed in a BIG way to being fully compatible with the AMICON standard, and the complete protocol will be availble on our TNCs. A separate software effort was begun following that meeting, with Margaret Morrison, KV7D spearheading the Tucson efforts. Margaret and Lyle have created a set of routines to interface the software and hardware of the TNC, and Margaret has recently completed a large part of a sophisticated on-board monitoring and debugging system.

The level 2 protocol routines are being put together now by a group that has already had considerable experience doing the X.25 logical link routines. Harold Price, NK6K and Dave Henderson, KD4NL were working earlier this year on some asynchronous point-to-point linking experiments using largely the same protocol.

Dave, Harold and Margaret have been working very hard together on the interface between high and low-level routines, and are pushing to complete a good set of routines for the first release of the boards to the Beta sites. A "soft" deadline of Thanksgiving weekend is the current target for the "EPROM burning party" for what we call the TAPR/AMSAT protocol.

The documentation for the software is actually being done at the same time as the routines are being written, and some very nicely worded interim reports have been generated by Harold and Dave. The software on both sides of the LA/Tucson connection has been pretty clean, and should be fairly easy for Pascal programmers to read. Chuck Green, NOADI has once again brought out the text editors and spelling-check programs, and has begun the task of integrating all of the software and hardware documentation into the first release of the TNC manual, which obviously has the same deadline as our board shipments.

Our final count for Beta test sites, incidentally, was 19, with several sites having over a dozen operators. These cities are scattered across the country, and a list of them will appear next month, along with information on how to contact the site coordinator. Linking these sites will be an interesting undertaking, and several methods will be tried. In addition to setting up a weekly hf net for all of the sites to discuss current problems and cute ideas, we'll be trying to follow in the footsteps of Tom Clark, W3IWI and Bob Diersing N5AHD with 10 meter long-haul links. Mike Parker, KT7D and Lyle are working on an L-band non-linear amplifier for use with the AMSAT Phase IIIB satellite, and Lyle and I are doing much of the planning for the new PACSAT packet satellite system. Some special linking experiments are being developed in the New York/New England area, and we'll have more to say about these efforts next month.

TAPR has experienced a strong period of growth, and we're now well over 200 members. The bi-monthly newsletter, Packet Status Register, is looking good, and will be used as a primary mecnanism for updating amateur packet operators with in-depth information on TNC hardware, linking experiments and the latest software releases, as well as continuing newsey articles and an occasional tutorial. For further information, please contact us at P.O. Box 22888, Tucson, AZ. 85734.

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THE DEAF AND THE TTY

Barry Strassler, Executive Director
Telecommunications for the Deaf, Inc.
814 Thayer Avenue
Silver Spring, MD 20910
301-589-3006 (Voice/TTY)

The Morse Code and Me

For the past couple of years, Paul Rinaldo attempted to persuade me, rather gently, that I could try to become a radio ham, despite my deafness. And I resisted, thinking it would be an excruciating experience to try to master the all-required Morse code exam. I do know for a fact that the person who developed the first workable deaf TTY/modem is deaf, is a licensed ham and was rather prominent among the circle of pioneering RTTY operators when this medium was in its infancy in the fifties.

I became interested finally, but in a kind of roundabout way. When Paul casually mentioned amateur TV as being part of ham radio, my eyes immediately lit up, and I asked for a demonstration. An appointment was arranged for another deaf friend and myself with another AMRAD member, Bruce Brown, who is very active with the Metrovision Amateur TV Club. After playing around with Bruce's TV paraphernalia, including a couple of on-air televised character-generated messages with a Baltimore TV amateur, I became overly fascinated. However, all moments of exhilaration must come to an end. I asked Bruce, "How do I become involved with Amateur TV?" His reply was terse, "You have to pass the Morse code first." So this is the story of my belated involvement in ham radio.

Along with Nan Sanders, I have been taking weekly Morse code lessons at the home of my Elmer, W4RI. It would have been nice to say that these sessions were a breeze, a couple of weeks, banging away at the key, and copying, and then an instant Novice ticket. But it was not the case. Being deaf and unable to hear at all, I had to depend on flashing lights and on sound vibrations. My deaf wife, incidentally wears a hearing aid, and she feels that if I went out and bought one, it could help me copy better. I haven't worn one since I last discarded it as a high school senior in the fifties. But anyway, as I have learned, the fists vary among the operators as much as personalities. W4RI's fist became easy for me and Nan to copy with just one exception. I have difficulty distinguishing between the dots - is it I or S? Is it S or H? Is it H or 5? Copying practice tapes like those sold by Radio Shack or by the ARRL was another problem for me. Perhaps it is due to the worn condition of my daughter's cassette recorder. Perhaps the tone/volume levels just show different series of vibrations as compared to the ones emitted on W4RI's code practice oscillator. Bear in mind that Nan and I place our forefingers on small speakers and try to get the best tone/volume vibration feel for ourselves. Despite these obstacles, the both of us were able to pass the required 5-wpm test, and are awaiting results of the written tests from the FCC. But our Elmer implores us not to stop at the Technician level, but to try for the General level in order to take advantage of hf RTTY. So, it is back to "school," trying to pick up our copying speeds.

We have been bombarded with suggestions for special devices to help us increase our speeds, the tactile pad, the hearing aid, the giant LED, computer software, etc. We probably will try some of them and then use the best method to enable us to hurdle 13 wpm.

As an encore, perhaps ignorance is damaging. I was never aware until I became hooked on ham radio, that of the four different mediums (voice, cw, RTTY and ATV) the deaf can use all except voice. I wish that I had been aware of that before.

AMRAD Amateur Radio Research and Development Corporation

Membership Application/Renewal

Mail to: Dr. William P. Pala, WB4NFB
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See reverse for overseas mailing rates.

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The Amateur Radio Research and Development Corporation (AMRAD) is a worldwide club of over 500 amateur radio and computer experimenters. It is incorporated in Virginia and is recognized by the U.S. Internal Revenue Service as a tax-exempt scientific and educational organization.

The purposes of AMRAD are to: develop skills and knowledge in radio and electronic technology; advocate design of experimental equipment and techniques; promote basic and applied research; organize technical forums and symposiums; collect and disseminate technical information; and, provide experimental repeaters.

Meetings are on the 1st Monday of each month at 7:30 P.M. at the Patrick Henry Branch Library, 101 Maple Ave E, Vienna, VA. If the first month is a holiday, an alternate date will be announced in the newsletter. Except for the annual meeting in December, meetings are normally reserved for technical talks - not business.

WD4IWG/R is an open repeater for fm voice and digital communications, especially for experimental modes. It is located at Tyson's Corner, McLean, VA. It features semi-private autopatch available to licensed members. Frequencies are: 147.81 MHz in, 147.21 MHz out. The repeater director is Jeff Brennan, WB4WLW.

WB4JFI/R is a 1200-baud half-duplex packet repeater in Falls Church, VA and may be accessed via WD4IWG/R frequencies.

WB5MMB/R is a 1200-baud simplex packet radio repeater which operates on 147.585 MHz from Vienna, VA.

The AMRAD CBBS, 703-734-1387, is operated by Terry Fox, WB4JFI. The system accepts 110, 300, 450 and 600-baud ASCII, Bell 103.

Handicapped Education Exchange, 301-593-7033, is operated by Dick Barth, W3HWN. HEX accepts 110/300-baud ASCII and Baudot deaf TTY/TDD calls.

AMRAD is affiliated with the American Radio Relay League (ARRL), Foundation for Amateur Radio (FAR), Northern Virginia Radio Council (NOVARC) and the Mid Atlantic Repeater Council (T-MARC).

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